to fresh westerly winds; light rain began 10:16 p. m., ended 11:10 p. m.; amount, .11 inch; thunderstorm; first heard, 10:20 p. m.; loudest, 11 p. m.; last, 11:06 p. m.; storm moved from northwest to southeast.

18th.—Weather clear and warmer; westerly winds, becoming high at 9:45 a. m., decreasing to light late in p. m.

Indianapolis, Ind., 17th.—Warm, clear in the forenoon; partly cloudy in the afternoon; near sunset, threatening clouds in the west; at 7 p. m. noted lightning southwest; heard first thunder at 7:07 p. m., loudest, 7:15 p. m., and last at 7:54 p. m.; light rain from 7:20 p. m. to 7:40 p. m.; frequent flashes of lightning followed by distant thunder; the storm moved from northwest to southeast; no change in temperature; wind, light south preceding; northwest during, and south after the storm; clear evening.

Columbus, Ohio, 17th.—Cloudy in the morning, clearing during the forenoon; a slight sprinkle of rain began and ended during the night of the 16th and 17th; rainfall 8 p. m. [16th] to 8 p. m. [17th], trace.

18th.—Clear weather and rapidly rising temperature in the morning; fresh to brisk southwesterly wind during the day, falling to light in the evening; thunderstorm; first heard at 3 a. m.; loudest, 3:20 a. m.; last, 4 a. m.; temperature before the storm, 68°; after, continued to rise; direction of the wind before the storm, south; after, southwest; light rain began and ended during the night of the 17th and 18th; rainfall, 8 p. m. to 8 p. m., 0.04 inch.

Cleveland, Ohio, 17th.—Slightly warmer, followed by slightly cooler; generally clear weather, followed at night by increasing cloudiness with a trace of rain during the night, and light rain beginning at 10:30 p. m. and continuing; slightly lower temperature; light to fresh south winds, veering to southeast, generally southwest, increasing in force after 11 p. m.

18th.—Northwest signals hoisted by local forecast official at 9:50 a. m.; following received at 11 a. m.: "Hoist southwest signals 10:20 a. m. at Cleveland, Erie, Buffalo, and on Lake Ontario; storm central over Lake Huron, moving east." Telegram calling for 1 p. m. special received at 12:52 p. m.; observation taken on time, filed 1:20 p. m.; much warmer and unusually close, muggy, generally clear weather; much lower barometer; high southeast winds veering to northeast, generally southwest, with storm velocity from 2:03 a. m. to 1:41 p. m.; a gale from 4:20 a. m. to 5:05 a. m., with a maximum of 40 miles southwest at 5:02 a. m., decreasing in force after 2 p. m.

Erie, Pa., 17th.—Partly cloudy, warm, and pleasant.

18th.—A thunderstorm raged from 1 to 3 a. m., accompanied by lightning and rain; during the storm the wind reached 28 miles from the west; the thunder claps were unusually loud and the lightning flashes terrific; it was a most severe storm and extended over a large portion of western Pennsylvania; horses were killed and trees blown down, but no loss of life reported. Amount of rainfall, .54 of an inch; cloudy and threatening, warm and depressing; clear at night.

Buffalo, N. Y., 17th.—Partly cloudy day, quite warm in daytime, with some threatening clouds at sunset; westerly winds fresh to brisk becoming northeast in evening.

18th.—Partly cloudy day, being cloudy with heavy rain in morning and light local rains during day, cooler; variable winds fresh and brisk at intervals when from the westward; thunderstorm moved from southwest to northeast; first thunder heard, 3:10 a. m.; loudest, 3:20 a. m.; and last, 4:15 a. m.; wind before, northeast; during, northeast-east; after, southeast; the temperature fell from 58° to 52°; up storm southwest signals at 9:15 by order of local forecast official, and order confirmed by Chief of Weather Bureau at 11:37 a. m., and down at 10:25 p. m.; no high winds during display, but threatening conditions on a. m. map demanded same.

Rochester, N. Y., 17th.—Very heavy dewfall in morning; measurement in gauge, 0.01 inch; mostly clear, slightly warmer, southwest to northwest fresh and brisk winds.

18th.—Light rain 1:15 to 1:25 a. m.; thunderstorm; first heard, 2:50; loudest, 3:20; last, 4:10 a. m.; moved from south to north; light rain 2:20 to 5:40 a. m.; temperature and wind direction before storm 63°, northwest; after, 56°, southeast; thunderstorm; first heard, 10:24; loudest, 10:32; last, 10:40 a. m.; moved from west to east; light rain 10:20 to 11:40 a. m.; temperature and wind direction before storm 56°, southeast; after, 59°, north; light rain 7:10 to 8:15 p. m.

Albany, N. Y., 17th.—Warmer, pleasant day; scattered clouds in the afternoon, principally cirro-cumulus, moving from the west; low percentage of humidity at the evening observation; character of day, 2, clear.

18th.—Light rain during night (17–18th) to 10:00 a. m.; 3:03 p. m. to 3:17 p. m. and 6:30 p. m. to 7:30 p. m; weather threatening, with considerable amount of rapidly-moving scud; special observations taken at 10:35 a. m. and 1:00 p. m.

New York, N. Y., 17th.—Light haze in morning; light fog from 7 p. m. to 9 p. m.; clear day.

18th.—Evidence of tornadic action was observed in the east of station between 9:10 a. m. and 9:20 a. m.; there was a bank of dark clouds in great confusion moving apparently from the south; distinct formation could not be fully observed on account of the dense fog at the time; beginning at 9:05 a. m. the barometer fell .2 inch in fifteen minutes; the wind shifted from southeast to south and increased from 8 to 48 miles an hour; the temperature fell about 3°; at 9:30 a. m. the wind backed to southeast then to northeast and to north; the barometer rose as quickly as it fell, making almost a perfect V on the barograph sheet; no damage was reported in this neighborhood; distant lightning observed in the east from 8 p. m. to 9 p. m.; light fog from 6 a. m. to 9 a. m.; dense fog from 9 a. m. to 10:10 a. m., then light from 10:10 a. m. to 5 p. m.; light rain began 7:25 a. m. and ended at 9:45 a. m.; light rain began 2:20 p. m.; ended 2:35 p. m.; southwest signals hoisted 10:35 a. m.; lowered 6:30 p. m.; partly cloudy day.

Philadelphia, Pa., 17th.—Partly cloudy and warmer; evening clear.

18th.—Light fog from about 4 a. m. to 9:30 a. m.; morning cloudy; light rain began 7:10 a. m., increasing to brisk shower after 8 a. m., and ending 9:50 a. m.; marked barometric fluctuations between 9 and 10 a. m.; barometer fell .15 inch in about forty-five minutes, and then rose sharply .05, followed by a very slight and gradual fall; the wind increased to 33 miles for a short time just before 10 a. m., and afterwards continued very brisk all day; special observation taken at 10:10 a. m.; day mostly cloudy with sunshine during middle portion. * * * Evening clear until about 10 p. m. when the sky clouded over for a short time with a sprinkle of rain at 10:06 p. m.; thunderstorm; first thunder heard at 10:06 p. m., loudest, 10:10, and last heard 10:20 p. m.; the storm came from the west and moved toward the east; temperature before storm, 75°; after, 74°; direction of wind before, southwest; after, southwest.

Harrisburg, Pa., 17th.—Day warmer and cloudy throughout; light showers at intervals; during forenoon light westerly winds prevailed.

18th.—Day opened with thunderstorm; first thunder, 7 a. m.; loudest, 7:40 a. m.; last heard, 7:15 p. m.; moved from west to southeast; temperature before, 63°; after, 80°; wind before, west; after, south; no hail; clearing and warmer during afternoon; distant lightning during evening.

Baltimore, Md., 18th.—Cloudy, with light fog in the early morning; light rain began at 8:20 a. m., followed by a thunderstorm; first heard, 9:15 a. m.; loudest, 9:40 a. m.; last, 11:10 a. m.; storm came from the northwest and moved toward the southeast; temperature before the storm, 72°; after, 69°; rain ended at 11 a. m., followed by partly cloudy and clear weather; total rainfall for day, 0.25 inch; slightly warmer; light, brisk, and fresh southwest winds.

Washington, D. C., 18th.—Partly cloudy; thunderstorm; first thunder, 9:40 a. m.; loudest, 10 a. m.; last, 10:55 a. m; storm moved from north to south; temperature before, 73°; after, 67°; direction of wind before, south; after, south; wind, 24 miles from north during storm; rain, 8:40 a. m. to 11:20 a. m.; cleared at noon; cloudy and partly cloudy during the evening; lightning northwest to north; clearing at 10 a. m.

New Haven, Conn., 17th.—Clear until 1:20 p. m.; partly cloudy remainder of the day; much clearer.

18th.—Cloudy day; light fog prevailed from 9:20 a. m. to 5:40 p. m.; light rain from 7:10 a. m. to 10:05 a. m., and from 9:22 p. m. to 9:27 p. m.

New London, Conn., 17th.—Clear and pleasant, slightly warmer; light, westerly winds.

18th.—Cloudy and threatening until 7:30 p. m., when it became clear and continued remainder of day; rain began 8:06 a. m. and ended 10:41 a. m.; began again 6:06 p. m. and ended 6:32 p. m.; amount for day, 0.17 inch; light, variable winds.

Block Island, R. I., 17th.—Clear and pleasant, decreasing pressure, fresh, southwest winds.

18th.—Slightly warmer; light rain began at 10:10 a. m. and ended at 11:15 a. m.; light, variable winds.

Nantucket, Mass., 17th.—Slowly falling barometer, rising temperature; light, westerly winds; light rain began and ended during night; amount, 0.01 inch; dense fog set in at 7 p. m.

18th.—Cloudy weather; light rain began 10:10 a. m.; southwest signal received 11:35 a. m.; rain ended 2:35 p. m.; amount, 0.06; gentle, becoming fresh, southeast winds shifting to northwest in evening; barometer fell rapidly in late a. m.

Boston, Mass., 17th.—Light clouds gathered before noon, at which hour a large, well-defined solar halo became visible; the clouds passed away at sunset, but returned shortly after the evening observation; the feature was the marked increase in temperature, the latter advancing 16° above the highest figure of yesterday, making the day seem very warm in contrast; west to southwest winds, brisk in the afternoon.

18th.—Threatening clouds in the early part of the morning turned to a light, drizzling rain which lasted till about 1 p. m., with cloudy skies throughout the remainder of the day; the prevailing north to east winds brought a low temperature, and the air was chilly and disagreeable; southwest signals ordered on Newport section in the morning, and information signals at Boston and section; special observations taken at 10:40 a. m. and 1 p. m.

LOCAL ATMOSPHERIC DISTURBANCES.

By A. J. HENRY.

In addition to the local thunderstorms, tornadoes, and hailstorms and such local phenomena as chinook winds, and diurnal land and sea breezes, there are still other disturbances less conspicuous to the eye and which might be thought to be purely local phenomena if we had not records from enough stations to show that they have a very general aspect. The

preceding paper shows that so-called barometric waves sweep over the country in connection with thunderstorms. May they not also occur without thunderstorms? Such a case may be that of June 20, 1898, when the wave-like oscillations of the barometer at Williston, North Dakota, between 8 p. m. and midnight, were very remarkable and were repeated on the 22d, between 2 p. m. and 9 p. m., and again on the 23d between 4 p. m. and 8 p. m., although with diminished intensity. Notable disturbances are also found on nearly the same dates at the neighboring stations, Miles City, Mont., and Bismarck, N. Dak., but are barely visible on the barogram for Moorhead. (See Chart XII*b*, on which the barograms are reproduced.)

The general weather maps of 8 p. m. June 20, and 8 a. m. June 21, show that an area of low pressure, with southeast winds, was passing eastward over this region of the country, followed by high pressure with northwest winds.

The daily journals of the stations are as follows:

Williston, N. Dak., June 20, 1898.—Clear weather with light to fresh southeast winds; thunderstorm began at 8:50 p. m., ended during night.

June 22, 1898.—Partly cloudy; rain began and ended during night of 21st; began again at 9:30 a. m.; ended 10:20 a. m.; total, 0.12 inch; light northwest to southeast winds.

June 23, 1898.—Cloudy; rain began and ended during night; began again 8:30 to 9:25 a. m., 10:20 to 10:40 a. m.; began 5 p. m. and continued; total, 1.11 inch; wind fresh from the north.

Miles City, Mont.—The station agent in charge of this station does not keep a daily journal, but he has entered the word "thunderstorm" against the 8 p. m. observation of the 20th, thus indicating that such a storm was in progress at that time.

Bismarck, N. Dak., June 20, 1898.—Continued hot weather; maximum temperature, 95°, minimum, 70°; barometer falling steadily and slowly; temperature above 90° most of the afternoon, and only for a high, southerly wind the heat would have been oppressive; but an occasional cloud to be seen during the day, and there was none at all just before sunset, but soon after a heavy bank of clouds appeared in the southwest horizon and rose steadily, accompanied by almost incessant lightning, followed by a thunderstorm; first thunder heard at 11:48 p. m. and continued; maximum wind velocity, 30 miles.

June 21, 1898.—Thunderstorm continued; loudest thunder heard at 12:53 a. m.; rain began at 12:15 a. m. and ended during night, being heavy for a short time after it began. The day was warm, but not so warm as yesterday, with a light, southerly wind shifting to northwest, and slight changes in barometer; the wind attained a maximum velocity of 34 miles from the southwest soon after midnight; the rainfall during the thunderstorm amounted to 0.45 inch; lightning in the eastern horizon began early in the evening and continued.

June 22, 1898.—Heavy thunderstorm began during night, no data; rain began during night, and ended at 8:10 a. m., followed by cloudy and threatening weather and another thunderstorm; first thunder heard at 12:14 p. m.; loudest at 12:16 p. m.; storm came from the southeast and moved toward the north; temperature before the storm, 76°; after, 78°; direction of wind before the storm, east; after, southeast; no hail nor maximum wind velocity; light rain began at 12:20 and ended at 12:36 p. m.; amount, 0.02. The day was partly cloudy and threatening for the greater portion of the time, with slightly lower temperature and stationary barometer, and fresh, generally easterly winds; lightning in the eastern horizon in the early evening.

Havre, Mont.—The barogram shows no disturbances in pressure on the 20th corresponding to those observed at Williston. It does show, however, marked oscillations of the barometer in connection with a thunderstom twenty-four hours earlier. The observer's journal on the 20th follows:

June 20, 1898.—Cloudy at 11:00 a. m.; rain began at 11:59 a. m. and ended at 5:10 p. m.; clearing at 5:30 p. m.; clear at 6:00 p. m.; partly cloudy day and cooler.

The reports of voluntary observers between Williston and Bismarck do not show, as a rule, the beginnings and endings of rainfall or thunderstorm and it is, therefore, impossible to trace the Williston storm southeastward toward Bismarck, or, in fact, in any direction, so far as could be discovered. This is perhaps not surprising in view of the paucity of observing stations in the vicinity of Williston, the nearest one being about 50 miles distant.

Moorhead, Minn. (about 200 miles due east of Bismarck), June 20, 1898.—Partly cloudy in the morning soon clearing; the day was very warm, with fresh to brisk southeast wind; maximum temperature, 90°.

June 21, 1898.—The day was partly cloudy, with fresh to brisk and high wind; maximum, 34, southeast at 12:45 p. m.; thunder at 11:20 p. m.; storm reported on 22d.

June 22, 1898.—Thunderstorm; thunder first heard at 11:20 p. m. of the 21st; loudest at 12:20 a. m.; last about 3:00 a. m.; the storm came from the southwest and moved toward the northeast; temperature before the storm, 71°; after, 63°; direction of wind before the storm, southeast; after, southeast; rain began 12:05 a. m.; ended during night, amount at 8:00 a. m., 0.10 inch; high wind in the early morning, maximum 35 southeast at 12:45 a. m.; wind continued brisk southeast. Thunderstorm (2d); thunder first heard, 3:55 p. m.; loudest, 4:40 p. m.; last, 5:10 p. m.; the storm came from the southeast and moved toward the northeast; temperature before the storm, 82°; after, 68°; direction of wind before the storm, southeast; after, southeast; no hail at station; rain began 4:40 p. m., ending 5:10 p. m.; total 24-hour rainfall, 0.14 inch.

Summarizing the foregoing by dates, we find that on the 20th thunderstorms occurred at Williston (latitude, 48° 9′ N.; longitude, 103° 35′ W.), Miles City (latitude, 46° 25′ N.; longitude, 105° 49′ W.), and Bismarck (latitude, 46° 47′ N.; longitude, 100° 38′ W.), beginning at 8:50, 7:55, and 11:48 p. m., respectively. The curves of each barogram, while differing among themselves in their sinuosities, all show a more or less marked disturbance of pressure about the time the thunderstorms began. The fact that the thunderstorm at Bismarck did not begin until about four hours after the one at Miles City suggests that after all there may have been a continuous line of thunderstorm development between the two places.

21st.—The thunderstorm of the 21st continued at Bismarck, but there were no thunderstorms or perturbations in the barograms at the remaining stations, if we except two small drops in the Moorhead curve about ten and fifteen hours after the principal drop at Bismarck.

22d.—The Williston observer reports that a rainstorm began during the night; the Bismarck observer, a heavy thunderstorm. Both barograms show marked oscillations of pressure beginning at 1 a. m. at Williston, and shortly before 2 a. m. at Bismarck. As the distance between the two stations is about 160 miles it seems evident that in this case there was no actual propagation of an atmospheric wave from the one station to the other. The Moorhead barogram shows a pressure oscillation very shortly before 11 p. m. of the 21st, and the observer reports a thunderstorm at 11:20 p. m., continuing until 3 a. m. of the 22d. Thunderstorms were, therefore, apparently in progress simultaneously at two of the stations and a rainstorm at the third.

ARE OUR WINTERS CHANGING?

By ALFRED J. HENRY.

The frequency and severity of the cold waves that have visited the southern portion of the United States in late years, and the fact that the present winter season began much earlier than usual have led a number of people to make inquiry as to what are the reasonable expectations for the future? Is it probable that a more or less permanent change in the character of the winters has taken place? This problem is important since it involves a possible readjustment of present economic conditions. It is not new, nor is it any nearer a clear and definite solution than it was fifty years ago. According to the trend of the best thought of to-day the climate is not perceptibly changing. The mean temperatures obtained by the earliest instrumental observations, both in this country and abroad, show no differences greater than might reasonably be due to the character of the instruments used and their environment. The yearly means for a single station do not show a steady increase in heat culminating in a period of high temperature and then gradually receding